

REMARKS

Summary of the Office Action

Claims 1 and 11 are objected to for minor informalities.

Claims 1, 11, and 20 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Shinichi (JP 3-152807) in view of Masaki et al. (JP 10-153788).

Summary of the Response to the Office Action

Applicants have amended claims 1 and 11 in accordance with the Examiner's suggestion, and amended claim 1 to better define the invention. Accordingly, claims 1, 11, and 20 are pending for consideration.

Objection to the Claims

Claims 1 and 11 have been objected to for minor informalities. Applicants have amended claims 1 and 11 in accordance with the Examiner's suggestions. Accordingly, Applicants respectfully request that the objection to claims 1 and 11 be withdrawn.

All Claims Define Allowable Subject Matter

Claims 1, 11, and 20 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Shinichi (JP 3-152807) in view of Masaki et al. (JP 10-153788). The rejection is traversed as being based upon a combination of references that neither teach nor suggest the novel combination of features now recited in independent claim 1, as amended.

With regard to independent claim 1, as amended, neither Shinichi nor Masaka et al., whether taken alone or in combination, teach or suggest at least the claimed combination of a wire comprising a Cu (copper) layer covered along at least one side by a first coating film made of titanium and covered along at least three sides by a second coating film made of titanium

oxide. In contrast to the Applicants' claimed invention, Shinichi teaches a multiple layered gate electrode including first, second, and third electrically conductive layers 12a, 1b, and 12c, respectively, and Masaki et al. teaches encasing a copper wiring with titanium oxide. Applicants submit herewith an English-language translation of Masaki et al. obtained from the Japanese Patent Office website to facilitate a detailed understanding of the teachings of Masaki et al. Applicants respectfully submit that the combined teachings of Shinichi and Masaki et al. would result in encasing the multiple layered gate electrode of Shinichi with a layer of titanium oxide such that the second copper metal layer 12b of Shinichi is only contacted along two sides by the titanium oxide layer taught by Masaki et al.

Accordingly, Applicants respectfully submit that the combined teachings of Shinichi and Masaki et al. do not teach or suggest the wiring structure recited by independent claim 1, and hence, dependent claims 11 and 20. Specifically, the combination of Shinichi and Masaki et al. do not teach or suggest a Cu (copper) layer covered along at least one side by a first coating film made of titanium and covered along at least three sides by a second coating film made of titanium oxide.

For at least the above reasons, Applicants respectfully assert that the rejection under 35 U.S.C. § 103(a) should be withdrawn because Shinichi and Masaki et al., whether taken alone or in combination, neither teach nor suggest the novel combination of features recited in independent claim 1, as amended.

CONCLUSION

In view of the foregoing, Applicants respectfully request reconsideration and reexamination of the application and timely allowance of the pending claims. Should the Examiner feel that there are any issues outstanding after consideration of the response, the Examiner is invited to contact the undersigned to expedite prosecution.

Attached hereto is a marked-up version of the changes made to the claims by the current attachment. The attachment is captioned "**VERSION WITH MARKINGS TO SHOW CHANGES MADE.**"

If there are any other fees due in connection with the filing of this response, please charge the fees to our Deposit Account No. 50-0310. If a fee is required for an extension of time under 37 C.F.R. § 1.136 not accounted for above, such as an extension is requested and the fee should also be charged to our Deposit Account.

Respectfully submitted,

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VERSION WITH MARKINGS TO SHOW CHANGES MADE

Claim 1 has been amended as follows:

1. (Twice Amended) A ~~{wiring}~~ **wire** comprising a Cu (copper) layer ~~{surrounded}~~ **covered** along at least one side by a first coating film made of titanium and ~~{surrounded}~~ **covered** along at least three sides by a second coating film made of titanium oxide.

Claim 11 has been amended as follows:

11. (Twice Amended) A TFT (thin film transistor) substrate having a ~~{wiring}~~ **wire** as claimed in claim 1.



PATENT ABSTRACTS OF JAPAN

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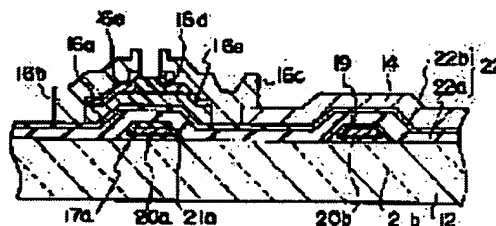
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(54) LIQUID CRYSTAL DISPLAY DEVICE

(57)Abstract:

PROBLEM TO BE SOLVED: To facilitate the constitution of a liquid crystal display device and to improve the adhesive property to a substrate, by constituting the device of a specific wiring material having a low resistance and the resistance to treatments with various kinds of chemicals in the later stages.

SOLUTION: A gate electrode line 17a comprises a metallic layer 20 consisting of an alloy of Cu and Zr and a ZrO oxide layer 21a covering the layer. The ZrO layer 21a is interposed between a conductive layer 20a and the substrate 12 as well. Similarly, a storage capacitor line 19 comprises a conductive layer 20b consisting of Cu and Zr and a ZrO insulating film 21b covering the same. An insulating film 22 is deposited on the substrate formed with such electrode layer 17a and wiring layer 19 and an a-Si layer 16a is formed in the TFT region atop the film. Further, a drain electrode layer 16b and a source electrode 16c are formed, on the other hand, a pixel electrode 14 consisting of ITO is formed in the pixel region on the storage capacitor line 19 and is electrically connected to the source electrode layer 16. The drain electrode layer 16b is electrically connected to a data line.



LEGAL STATUS

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1. This document has been translated by computer. So the translation may not reflect the original precisely.
2. **** shows the word which can not be translated.
3. In the drawings, any words are not translated.

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[The technical field to which invention belongs] Especially this invention relates to the wiring layer and electrode layer which have been arranged on the substrate of a liquid crystal display about a liquid crystal display.

[0002]

[Description of the Prior Art] A large area, highly minute, and a high-definition and cheap panel display (flat type television) are realizable by constituting a TFT array using the a-Si film to which TFT (TFT) using the amorphous silicon (a-Si) film is made as for low-temperature membrane formation using a cheap amorphous glass substrate in the active matrix type liquid crystal display formed as a switching element.

[0003] By the way, it is indispensable for it to be thin and to make thinly and long electrode wiring of the address line linked to the gate of the data line which connects this kind of active matrix type liquid crystal display to the source of TFT and a drain in order to large-area-ize and to gather the numerical aperture of a pixel, highly-minute-izing and, or TFT etc.

[0004] And in order to lose the waveform distortion of a pulse signal and to have to make wiring resistance low enough, the resistivity of the charge of wiring material must be small. Moreover, a gate line is formed on a glass substrate, for example, and when adopting the reverse stagger type TFT structure which constitutes TFT for an insulator layer or an a-Si film in piles on this, the gate electrode line which becomes the gate of the address line or TFT needs to consist of material which can bear chemical treatments, such as etching in a subsequent process.

[0005] Although various metals, such as Ta, Ti, and Cr, and the alloy containing those elements are used as a material for the address line or gate electrode wiring which fills such a demand conventionally, in order to attain large-area-izing and highly minute-ization further, more, by low resistance, processability is good and material which was moreover excellent in resistance in various chemical-treatment processes is desired.

[0006] About the resistivity of wiring, 10 or less microomegacm are required to 15 or less microomegacm and 1280x1028-pixel GURAFIKUAREI 20 inches or less to 25 or less microomegacm and 1028x768-pixel GURAFIKUAREI 15 inches or less to a 640x480-pixel graphic array 12 inches or less. then -- more -- low -- ITO [in / a back process / although metals, such as aluminum and Cu, could be considered, when the address line and a storage-capacitance line are formed, for example by aluminum and Cu as a wiring material / ****] /, aluminum, SiNx, and SiOx Since there is no resistance over the ** etching solution, there is a problem of an open circuit occurring.

[0007] For this reason, although the wiring which covered with acid-proof good Ta and the Cr layer 3 the front face of the aluminum wiring 2 formed by carrying out patterning on the substrate 1 is used as shown in drawing 7 , if such wiring is used, the formation process of a metal membrane and patterning, and the process of etching will increase by a unit of 1 time, respectively, and will produce the problem that cost increases. Moreover, since masks, such as a resist, are required in order to restrict the flexibility of a circuit pattern -- there is the need of short-circuiting wiring in order to anodize aluminum -- and to prevent oxidization of the contact section of wiring, in case it is anodic oxidation although the wiring which anodized and protected the front face of aluminum is also used, there is a problem that a mask process increases and cost increases. Moreover, it is difficult to reduce metaled resistivity, since the rate between the subject metals and addition metals between subject metals and addition metals is the same, and to solve raising the property of an oxide film simultaneously. [in / an internal metal part / at anodic oxidation] / in / an oxide film / comparatively]

[0008] Moreover, in the case of the sources, such as the data line, and the stagger type TFT structure of forming drain

electrode wiring in a substrate side, the same property as a source drain electrode material will be required. Furthermore, also in the case of the liquid crystal display which does not carry out a TFT drive, the same problem exists.

[0009]

[Problem(s) to be Solved by the Invention] although low resistance wiring materials, such as Ag, Au, Pt, etc. besides Above aluminum and Cu, can be considered as a material which realizes low resistance-ization of the above-mentioned wiring -- aluminum and Cu -- very much -- acid resistance and alkali resistance -- weak -- SiOx etc. -- even if it covers with an oxide film, a chemical will make the various chemical treatments of a back process corrode a wiring material through the pinhole of an insulator layer etc., and an open circuit will be caused Moreover, Ag, Au, Cu, and Pt have the weak adhesion of the coat to a substrate, and tend to exfoliate. moreover, Au and Pt -- SiOx and SiNx etc. -- when an insulator layer is formed on it, since the adhesion force is weak, there is a problem that an insulator layer tends to separate

[0010] this invention is made in view of this point, and it consists of wiring materials with the resistance over the various chemical treatments in low resistance and a back process, and composition is easy, and the covering nature to a substrate is good and aims at offering the liquid crystal display equipped with the reliable wiring layer or the electrode layer.

[0011]

[Means for Solving the Problem] The electrode by which this invention was formed in the front face by the side of the substrate of a couple, the liquid crystal layer pinched among these substrates, and the aforementioned liquid crystal layer of the aforementioned substrate, The wiring layer which was electrically connected to the aforementioned electrode and was arranged in the front face of the aforementioned substrate is provided. at least the aforementioned wiring layer A kind of 1st metal chosen from the group which consists of Ag, Au, Cu, aluminum, and Pt is made into a subject at least. The conductive layer which consisted of material which contains at least a kind of 2nd metal chosen from the group which consists of Ti, Zr, Hf, Ta, Nb, Si, B, La, Nd, Sm, Eu, Gd, Dy, Y, Yb, Ce, Mg, Th, and Cr, The liquid crystal display characterized by having the oxide layer which consisted of material which the front face of this conductive layer is covered and makes the 2nd metal of the above a subject is offered.

[0012] As for the ratio of the 2nd metal of the above to the 1st metal of the above in the material which constitutes a wiring layer, in this invention, it is desirable that the material which constitutes the aforementioned oxide layer is larger than the material which constitutes the aforementioned conductive layer.

[0013] Here, it means that it is higher than the rate of the 2nd metal to the 1st metal in a conductive layer of the 2nd metal to the 1st metal [make / the 2nd metal / into a subject] in an oxide layer comparatively.

[0014]

[Embodiments of the Invention] Hereafter, the gestalt of operation of this invention is concretely explained with reference to a drawing. Ag, Au whose liquid crystal display of this invention is the wiring material of low resistivity, Ti to which acid resistance tends to react to the 1st metal, such as Cu, aluminum, and Pt, with oxygen well, The wiring layer which consists of material which added the 2nd metal, such as Zr, Hf, Ta, Nb, Si, B, La, Nd, Sm, Eu, Gd, Dy, Y, Yb, Ce, Mg, Th, and Cr Oxide layers which corrosion resistance becomes from TiO, good ZrO, good HfO, etc. with the strong adhesion force are consisted of by the front face, thereby, corrosion resistance is good at low resistance, and wiring with the powerful adhesion force can be realized.

[0015] Since the 2nd metal is diffused on a front face at the oxidization process which forms an oxide layer, concentration becomes high more on a front face. For this reason, this oxide layer serves as a more nearly quality protective coat. On the other hand, inside a wiring layer (conductive layer), since the purity of the 1st metal becomes high (the concentration of the 2nd metal becomes low), it becomes low resistance more. Moreover, since this oxide layer is excellent chemical-resistant, it demonstrates the resistance which was excellent also in the chemical treatment in a process.

[0016] Therefore, a large area with few defects, highly minute, and a high-definition liquid crystal display (liquid crystal display) are realizable by using the metal wiring which consisted of above-mentioned material as an address line.

[0017] The wiring layer in this invention is low resistance, and is wiring structure which shows resistance to the various chemical treatments of a back process. To namely, the 1st metal of Ag, Au, Cu, aluminum, and Pt which is the wiring material of low resistivity Ti, Zr, Hf, aluminum, Ta, Nb to which acid resistance tends to react with oxygen well,

Si, B, La, Nd, Sm, Eu, Gd, Dy, Y, Yb, Ce, The conductive layer which consisted of material which comes to add ***** , such as Mg and Cr, by heat-treating in oxidizing gases, such as O₂, ozone, N₂ O, and H₂ O the front face of the metal layer (conductive layer) which consists of an alloy of Ag, Au, Cu, aluminum, Pt, and the 2nd metal -- TiO_x, ZrO_x, HfO_x, AlO_x, and YO_x etc. -- from -- it comes to form the becoming oxide layer

[0018] TiO_x etc. -- since acid resistance is strong and is strong, it is corroded by etchant and an oxide does not generate an open circuit [of the adhesion force over a substrate] Moreover, since the interior (conductive layer) is Cu of low resistance, aluminum, etc., it is low resistance as a whole. Therefore, a corrosion resistance good wiring layer is realizable by low resistance. Moreover, since corrosion resistance and heat-resistant Ti, good Zr, and good Hf are added to Ag, Au, Cu, internal aluminum, internal Pt, etc., even if a surface oxide layer is torn, an internal conductive layer can prevent *****ing.

[0019] Moreover, in order for the metal of a conductive layer itself to oxidize, oxides with the strong adhesion force, such as the oxide of the 2nd metal contained in the material of a conductive layer, for example, TiO_x, and ZrO_x, are formed also in the interface of a substrate and a conductive layer as a result. For this reason, even if it uses the weak low resistance metal of the adhesion force comparatively as opposed to [Au / Cu,] a substrate, the adhesion force between substrates improves with the oxide of the 2nd metal.

[0020] Furthermore, the wiring material concerning this invention is explained in full detail. a glass-substrate top -- Cu (the 1st metal) -- Ti (the 2nd metal) -- 20at(s)% (atomic %) -- the alloy film which consists of an added alloy was formed by sputtering, and the sample was created Thickness of this alloy film was made into 3000Å. The concentration of the addition metal at this time (Ti) is chosen in 1 - 20at%.

[0021] The pressure of 35Pa and oxidation treatment for 30 minutes were performed to this sample in oxygen atmosphere. Moreover, it is NH₃ to the almost same sample because of comparison. The pressure of 35Pa and nitriding treatment for 30 minutes were performed in atmosphere. The relation between processing temperature and the resistivity of an alloy film is shown in drawing 4 . In addition, the value of 25 degrees C is a value before oxidation treatment and nitriding treatment.

[0022] It is before processing and is 186microomegacm, and the resistivity by oxidation treatment is after [of 450 degrees C] processing, is 16microomegacm, and decreased or less to 1/10 so that drawing 4 might show. About the resistance after processing here, if Ti concentration at the time of sputtering membrane formation is reduced or oxidation treatment is fully performed, since the purity of internal Cu will improve, it is possible to make it fall to about 3 microomegacm. On the other hand, it is before processing and is 133microomegacm, and the resistivity in nitriding treatment order is after [of 450 degrees C] processing, is 69microomegacm, and did not fall to 2 by about 1/. Consequently, it turns out that oxidation treatment has the operation which reduces resistivity at low temperature more rather than nitriding treatment.

[0023] Next, tape ** carried out the adhesion force of this oxidized sample, and it investigated by the test. Consequently, it checked that an alloy film did not separate from a glass substrate and it had sufficient adhesion force to glass. This is good TiO_x of the adhesion force to an interface with a substrate. It is thought that it is because it was formed.

[0024] Moreover, after carrying out pattern formation of this alloy film to a wiring configuration, oxidation treatment was performed to one sample and nitriding treatment was performed to the sample of another side. The cross section of the CuTi alloy wiring after oxidation treatment and nitriding treatment (drawing 6 (A)) (drawing 6 (B)) is shown in drawing 6 (A) and (B), respectively.

[0025] When the side portion of the circuit pattern of the sample which performed oxidation treatment was observed, the crack was not seen as shown in drawing 6 (A). oxide film 33b by which this is formed in a glass substrate 31, oxide film 33a formed in the interface of the alloy film 32, and the front face of the alloy film 32 -- both -- TiO_x it is -- there is no big difference in both property, and it is thought that it is because the stress generated between oxide film 33a and 33b is small

[0026] On the other hand, when the side portion of the circuit pattern of the sample which performed nitriding treatment was observed, as shown in drawing 6 (B), the minute crack 34 occurred. When nitriding treatment is performed, since TiO_x 33a is formed, the nitride film (TiN_x film) 35 is formed in the front face of the alloy film 32 and both properties differ greatly, this is considered to be for stress to occur among both by the interface of a glass substrate 31 and the alloy film 32. Therefore, it turns out that it is the method in which oxidation treatment excelled nitriding treatment more also from a viewpoint which prevents the crack initiation in a wiring layer.

[0027] Next, they are aluminum etching reagent (mixed liquor, such as phosphoric acid, a nitric acid, and an acetic acid), an ITO etching reagent (mixed liquor, such as HCl, HNO₃, and H₂O), and SiO_x about the sample which performed this oxidation treatment. It dipped in the etching reagent (**-ized ammonium solution). Consequently, it did not *****, but acid resistance came out of most of this wiring layer enough, and a certain thing was checked. When investigated about acid resistance like [metal / which does not add an acid-proof metal] the above, to aluminum etching reagent, it was very weak, and Cu film of 3000Å of thickness dissolved altogether within 1 minute.

[0028] Next, composition of the depth direction of this oxidized sample was investigated. Consequently, it turns out that about 500Å titanium oxide membrane layer is formed on the glass substrate, the layer which makes about 2000Å Cu a principal component is on this, and about 1500Å titanium oxide layer is formed on this. The thickness of the film of these layers can be adjusted by adjusting the thickness, Ti concentration, or the processing conditions at the time of membrane formation by sputtering, and if there is 300Å or more of 100Å or more of titanium oxide layers on a glass substrate preferably, adhesion force sufficient between a glass substrate and an alloy film will be acquired. Moreover, if there is 100Å or more of thickness of a upside titanium oxide layer, acid resistance will improve. 500Å or more is preferably effective. Moreover, when resistivity and acid resistance are taken into consideration, as for Ti concentration of Cu alloy film after oxidation treatment, it is desirable that it is 1 - 10at%.

[0029] Next, other wiring materials are explained. a glass-substrate top -- respectively -- aluminum -- Ti -- 15at(s)% -- the alloy film which consists of an added alloy, and aluminum -- Zr -- 15at(s)% -- the alloy film which consists of an added alloy was formed by sputtering Thickness of each alloy film was made into 3000Å. The concentration of the addition metal at this time (Ti, Zr) is chosen in 1 - 20at%.

[0030] Subsequently, oxidation treatment for 30 minutes was performed to this sample in oxygen atmosphere. The relation between the processing temperature about these samples and the resistivity of an alloy film is shown in drawing 7 . In addition, the value of 25 degrees C is a value before oxidation treatment.

[0031] In AlTi, processing before was 72microhm-cm, 450-degree-C processing back is 14microhm-cm, and the resistivity in oxidation treatment order decreased to abbreviation 1/5 so that drawing 7 might show. Moreover, in AlZr, processing before was 70microhm-cm, and the processing back is 16microhm-cm and decreased to 4 by about 1/.

[0032] If there are 50Å or more of the titanium oxide layer and 300Å or more of zirconium-oxide layers on a glass substrate preferably, adhesion force sufficient between a glass substrate and an alloy film will be acquired. Moreover, if there are a upside titanium oxide layer and 40 upsideÅ or more of zirconium-oxide layer thickness, acid resistance will improve. Preferably, 100Å or more is effective. Moreover, when resistivity and acid resistance are taken into consideration, as for Ti concentration and Zr concentration of aluminum alloy after oxidation treatment, it is desirable that it is 1 - 10at%.

[0033] They are aluminum etching reagent (mixed liquor, such as phosphoric acid, a nitric acid, and an acetic acid), an ITO etching reagent (mixed liquor, such as HCl, HNO₃, and H₂O), and SiO_x about the sample which performed these 450-degree C oxidation treatments. It dipped in the etching reagent (**-ized ammonium solution). Consequently, it did not *****, but acid resistance came out of most of these wiring materials enough, and a certain thing was checked. With aluminum which does not add an acid-proof metal, it dissolved altogether in about 2 minutes by aluminum etching reagent. Moreover, tape ** carried out the adhesion force of a sample in which it these-oxidized, and it investigated by the test. Consequently, an alloy film does not separate from a glass substrate and it was checked that there is sufficient adhesion force to glass.

[0034] Furthermore, other wiring materials are explained in full detail. a glass-substrate top -- respectively -- Ag, Au, and Pt -- respectively -- Ti, Zr, and Hf -- each -- 1 - 20at% -- the alloy film which consists of an added alloy was formed by sputtering, respectively Each alloy film fully acquired the low value to about 45 microhm-cm of the Mo-Ta alloy with which resistivity is used from the former as 10 or less microhm-cm after membrane formation or annealing etc.

[0035] these alloy films -- a phosphoric acid system aluminum etching reagent and a rare HF and ITO etching reagent (mixed liquor, such as HCl, HNO₃, and H₂O) -- dipping -- etching -- the bottom acid-proof metals, such as Ti, Zr, and Hf, -- more than 1at% -- if added, it is satisfactory for acid resistance -- things were understood thus, Ti, Zr, and Hf -- more than 1at% -- by adding, the acid resistance over an ITO etching reagent became sufficiently strong, and the defect of an open circuit became zero mostly

[0036] Resistivity increases with the increase in the addition of Ti, Zr, and Hf. For example, if the addition of the aforementioned metal is less than [10at%], increase of resistivity is 3 or less times, and can be used as the address line

of a large-sized highly minute TFT switching type liquid crystal display. if an addition is preferably made 5at(s)% -- resistivity -- more -- low -- ** -- it is desirable at **

[0037] In addition, in a liquid crystal display, in order to use the heat-resistant weak substrate of glass etc., it is necessary to make oxidation-treatment temperature into 450 degrees C or less. O₂ When performing oxidation treatment only using gas, 450 degrees C or more of reaction temperature are needed. On the other hand, it is possible by using ozone, N₂ O, etc. to make processing temperature low at 450 degrees C or less.

[0038] Although the front face of Cu or aluminum can be nitrided, a nitride film can be formed as other protective coats and a front face can be protected For example, the standard free energy of formation which is a reactant index receives, although HfN is -375.1kJ/mol. HfO₂ As opposed to being -1088.2 kJ/mol, and HfZrN being -366.2kJ/mol HfZrO₂ As opposed to being -1042.8 kJ/mol, and TiN being -339.4kJ/mol TiO₂ It is aluminum 2O₃ to being -888.8 kJ/mol and AlN being -287kJ/mol. It is B-2 O₃ to being -791.2 kJ/mol and BN being -228kJ/mol. It is -597.2kJ/mol. Therefore, it turns out that the oxidation reaction is performed at low temperature rather than nitriding treatment. Although slight acid resistance is inferior, since the oxidizing quality is large, actinoids system metals, such as lanthanum system metals, such as Ce and Nd, and Th, can form an oxide film in a front face at low temperature (400 degrees C or less) more.

[0039] In the case of aluminum, it is aluminum 2O₃. It is as large as -791.2 kJ/mol. However, in the case of pure aluminum, it is aluminum 2O₃. Since the blocking property is good, if 2Oaluminum₃ thin film is formed in a front face, in order to interfere with transparency of O, only a thin oxide film will be formed. On the other hand, when Ti is added to aluminum, transparency of O is aluminum 2O₃. Since it is not prevented a forge fire, a thick oxide film is formed and acid resistance and thermal resistance improve.

[0040] moreover, the low melting points, such as Cu, Au, and aluminum, -- low -- a metal and the 2nd metal -- alloying -- more -- Ti 2O₃, ZrO₂, and aluminum 2O₃ etc. -- formation temperature can be low-temperature-ized [****] In addition, 1 - 10at% of each addition of Ag, Cu, and aluminum is desirable when oxidization temperature and resistivity are taken into consideration.

[0041] What is necessary is just to choose oxidation-treatment temperature among 250-450 degrees C that what is necessary is just to choose suitably with a metaled combination. If internal additions, such as Zr, Ti, and Hf, can be controlled by this and it controls between 1 - 5at%, good wiring of corrosion resistance and the adhesion force is realizable by low resistance. For example, if it is a bigger object for VGA than this, if it is a 1080x1028-pixel object for super EKUSUTENDOGURAFFIKU arrays (SXGA), it is desirable [if it is an object for GURAFFIKKU arrays (VGA), less than / 1-10at% / is desirable, and] 1 - 5at% from the point of resistivity that it is 0.5 - 3at%. On a scaling film, it is desirable more than 5at% and to add more than at 10at% preferably.

[0042] As gas for oxidation treatment, it is O₂. Oxidizing gases, such as not only gas but N₂ O gas, ozone gas, or H₂ O gas, can be used. O₂ [moreover,] plasma-izing gas and N₂O gas and heat-treating them -- TiO₂ etc. -- formation temperature of an oxide film can be low-temperature-ized to 250-350 degrees C Thus, since an oxide film is formed also in a substrate interface by oxidizing by the gaseous phase, the acid resistance of the substrate interface section also improves, and the adhesion force also improves. For this reason, rather than the case where only a front face is oxidized with plasma treatment or an ion implantation, acid resistance improves further and the yield improves.

[0043] In addition, in the above, although it is usable since acid resistance and the adhesion force are sufficiently good even if it does not oxidize a front face if the addition to the 1st metal of Ti, Zr, and Hf which are the 2nd metal is increased to 5 - 10at%, resistivity becomes high in this case. Therefore, it is suitable with high definition more large-sized [to have oxidized the front face, to have reduced the internal (conductive layer) addition of Ti, Zr, and Hf, and to lower resistivity].

[0044] As a metal to oxidize, the one where the free energy of formation of an oxide is smaller is good, and a -500 kJ/mol [less than] object has especially the good standard free energy of formation. The standard free energy of formation of the oxide of the 2nd metal, such as Ti, Zr, and Hf, is a value per metal 1 element. ThO₂ -1169.2 kJ/mol, HfO₂ -1088.2 and CrO₂ -1058.1 and ZrO₂ -1042.8 and CeO₂ -1024.6 and Ta 2O₅ -955.6 and Gd 2O₃ -909.8 and Y₂ O₃ -908.3 and Er₂ O₃ -904.4 and Dy 2O₃ -885.8, Nd 2O₅-883.0, and Sm 2O₃ -867.3 and Yb 2O₃ -863.4 and Nd 2O₃ -860.4 and La 2O₃ -852.9 and Eu₂ O₃ -778.4 and Ti 2O₃ -717 and MgO are -569.3kJ/mols. Thus, free-energy-of-formation deltaG is able to form a good oxide film in a front face at low temperature, since it is small. In addition, by forming an oxide film before gate insulator layer deposition, and carrying out at the time of substrate heating before membrane formation, it can perform without the increase in a process and cost does not increase.

[0045] In this invention, it is good also considering the 1st metal and 2nd metal as the same thing. For example, when aluminum is used for the 1st metal used as the subject of a wiring layer and aluminum is chosen as the 2nd metal which is *****, the 1st and the 2nd metal are set to the same aluminum as a result. Even in this case, the protective layer in which a substrate side also forms aluminum wiring simultaneously with the good wiring layer and this good of chemical resistance and adhesion, maintaining expected low resistivity by wrap composition with an aluminum oxide can be obtained.

[0046] When the 1st metal is the acid-proof lows Cu and aluminum, ***** with oxidizing qualities strong as 2nd metal group, such as Ti, Zr, and Hf The acid resistance of rare earth, such as Au, Pd, Cr, germanium, Ag, and Sm, etc. adds both strong acid-proof metals with an oxidizing quality smaller than *****. It can leave the strong acid-proof metal of oxidizing qualities, such as Ti, Zr, and Hf, to the interior (conductive layer) at the time of oxidation treatment, and a process margin can also be enlarged. Moreover, since the resistivity of an alloy changes with the amounts of an addition metal, when adding only *****, the amount of the addition metal which remains in the interior (conductive layer) by the degree of oxidization of ***** may change, and resistivity may vary. By adding ***** and an acid-proof metal, this problem can be prevented and a manufacture margin can be enlarged.

[0047] Furthermore, two kinds can be chosen from the inside of the strong metal of an oxidizing quality like Ti, Zr, Hf, Sc, and Si as a sorting by selection of ***** and an acid-proof metal, for example, the biggest metal of an oxidizing quality can be oxidized as ***** among these groups like Zr, and also let the weak metal of an oxidizing quality like Ti be a metal for acid-proof disposition tops for a while.

[0048] Wiring of this invention cannot be restricted to reverse stagger type TFT, and can be similarly applied in an etching stopper / reverse stagger type, a back channel / reverse stagger type, and stagger type TFT. Moreover, you may use not only for a gate line but for a signal line etc. Moreover, the semiconductor film of TFT may not be what was restricted to the a-Si film, but may be a polysilicon contest film.

[0049] Although the Zr-aluminum alloy gate line which anodized aluminum front face is known, in this case, an Zr/aluminum ratio is almost equal at the oxide film of the interior of wiring, and a front face. For this reason, if the amount of Zr is increased in order to improve acid resistance, the internal amount of Zr also cannot but increase. For this reason, there is limit that wiring resistance will go up. On the other hand, in this invention, the internal amount of Zr is reduced and formed into low resistance, and in order to improve acid resistance, the surface amount of Zr can be increased.

[0050] When the thickness of the oxide film formed in a front face takes acid resistance and thermal resistance into consideration that there should just be 40A or more, 300A or more is desirable. More than 5at% is required for it, and when the amount of addition metals in an oxide takes acid resistance into consideration, more than its 10at% is desirable. 300A or more is preferably required for the oxide film of a substrate interface 50A or more in thickness.

[0051] Next, a book

(Example 1) Drawing 1 - drawing 3 show the active matrix type liquid crystal display of this invention. As shown in drawing 1, the liquid crystal display 10 is constituted by making the field by the side of each electrode meet, and arranging the observation side substrate 11 of the glass in which the transparent common electrode 13 of an ITO (indium stannic-acid ghost) film was formed in one field, and the opposite substrate 12 in which the transparent pixel electrode 14 of an ITO film was formed in one field.

[0052] Through a substrate gap agent (spacer), both the substrates 11 and 12 set a several micrometers gap, are arranged, and seal a periphery, and this gap is filled up with the liquid crystal layer 15. Therefore, the liquid crystal layer 15 is pinched by both substrates.

[0053] The opposite substrate 12 with the pixel electrode 14 is called a matrix substrate, and the pixel electrode 14, the TFT switching element 16 and the address line (gate line) 17, the data line 18, and the storage-capacitance line 19 are superficially arranged in an equivalent secondary side array with the circuit shown in drawing 3. That is, the n address lines 17 extended by the line writing direction of a screen display and the m data lines 18 extended in the direction of a train are arranged in the shape of a matrix, and the storage-capacitance line 19 is arranged still in parallel with each address line.

[0054] The TFT switching element 16 and the pixel electrode 14 are formed in the field unit which the address line and the data line surround, and TFT16 is electrically connected to the address line 17 and the data line 18 by the intersection of a field unit. That is, a source electrode is connected to the pixel electrode 14, and a gate electrode is

connected to the data line 18 for the drain electrode of TFT at the address line 17. In addition, in drawing, sign 15a is the liquid crystal portion pinched by the pixel electrode 14 and the common electrode 13, a part for a liquid crystal layer, i.e., the field unit, of a field unit, and forms 1 pixel each.

[0055] Drawing 2 expands and shows the arrangement cross section of gate electrode line 17a extended in one from the TFT switching element 16 on a glass substrate 12, and the address line, and the storage-capacitance line 19, and gate electrode line 17a consists of metal layer 20a which consists of an alloy of Cu and Zr, and ZrO oxidizing-zone 21a which covers this. ZrO layer 21a intervenes also between conductive-layer 20a and a substrate 12. The storage-capacitance line 19 consists of conductive-layer 20b which consists of an alloy of Cu and Zr, and ZrO insulating-layer 21b which covers this similarly. Although not illustrated to drawing 2, pattern formation also of the address line 17 is carried out simultaneously.

[0056] On the substrate in which these electrode layer 17a and the wiring layers 17 and 19 were formed, an insulator layer 22 accumulates, a-Si layer 16a is formed in the TFT field of the upper surface, and drain electrode layer 16b and source electrode 16c are formed further. On the other hand, the pixel electrode 14 which consists of ITO is formed in the pixel field on the storage-capacitance line 19, and it connects with source electrode layer 16c electrically. Although drawing 2 does not show drain electrode layer 16b, it is electrically connected to the data line.

[0057] Next, the process of the address line 17 of this composition, gate electrode line 17a, and the storage-capacitance line 19 is explained further. First, on the glass substrate 12, sputtering of Cu and the Zr was carried out simultaneously, the Zr10at% (atomic %) CuZr alloy film was formed by 3000Å in thickness, it etched with the phosphoric acid system solution, and the CuZr alloy-layer pattern of the address line 17 with a line breadth of 20 micrometers, gate electrode with a line breadth of 12 micrometers line 17a, and the storage-capacitance line 19 with a line breadth of 35 micrometers was formed.

[0058] Subsequently, it is this O₂ It heat-treated at 400 degrees C in atmosphere, Zr in a pattern was oxidized, and the oxidizing zones 21a and 21b of ZrO were formed in the front face of an alloy film. That is, Zr of a CuZr alloy layer was spread on the front face with this heat treatment, and it oxidized, and became the oxide-film layers 21a and 21b of ZrO, and the concentration of Zr in internal CuZr conductive-layer 20a and 20b decreased, and became 2at%. In addition, oxidizing zones 21a and 21b were formed also between the conductive layer and the substrate 12. Moreover, the thickness of the oxidizing zone on the front face of a conductive layer was 1000Å.

[0059] Subsequently, it is SiO_x with a thickness of 3000Å as an insulator layer 22 by the plasma CVD method. Film 22a and SiO_x with a thickness of 500Å The laminating of the film 22b is carried out, and they are 1000Å in thickness, and Stopper SiO_x about undoping a-Si layer 16a further. 16d of films was deposited 2000Å in thickness. Stopper SiO_x After *****ing a film, n+a-Si layer 16e was deposited 500Å in thickness.

[0060] Subsequently, after depositing Mo 500Å in thickness, patterning was carried out and the island of a-Si was formed. After forming the ITO pixel electrode 14, opening of the contact hole was carried out. Then, after depositing 500Å in thickness, and aluminum layer for Mo layer used as drain electrode layer 16b and source electrode layer 16c 5000Å in thickness, this drain electrode 16b and source electrode 16c were formed by aluminum etching reagent. At the time of formation of aluminum layer with a thickness [this] of 5000Å, the data-line pattern is formed simultaneously, and the data line 18 is formed with aluminum.

[0061] Subsequently, n+a-Si layer 16e is *****ed by CDE, and it is SiN_x. The protective coat was formed, opening was prepared in the contact section, and the TFT array was completed. In the constituted matrix substrate 12 for a liquid crystal drive thus, the address line Although it consists of a Mo-Ta alloy used conventionally, it compares with about 30 to 45 resistivity microohm-cm. Less than 10 microohm-cm of resistivity -1/4 or more [whose] is a small value 1/3 is realizable, since width of face of the address line can be conventionally made small, expansion of a numerical aperture can be aimed at, and corresponding to a large area, highly minute, and a high-definition liquid crystal display, it can respond also to increase of a wire length conventionally. Moreover, they are ITO, aluminum, SiO_x, and SiN_x by surface oxidation. Since the resistance over an etching solution was also improving, compared with the case where aluminum, Cu(s), and these alloys are used for a gate line, the defect by open circuit decreased by leaps and bounds.

(Example 2) 10at%Zr was added to Au like the example 1. Since acid resistance was good compared with Cu and Au did not need to leave Zr to the interior (conductive layer), it lengthened time at 400 degrees C, and fully oxidized Zr. Au was [the melting point of the internal amount of Zr] less than [0.5at%] from Cu at the low sake. Thereby, resistivity was made low enough with 3 or less microohm-cm.

(Example 3) 10at%Zr was added to aluminum like the example 1. Since the melting point was low compared with Cu, aluminum has oxidized at 250-350 degrees C lower than Cu. The internal amount of Zr was 2at(s)%. Thereby, resistivity was 10 or less microomegacm.

(Example 4) 10at%Zr and 3at%Ti were added to Cu like the example 1. When it oxidized at 400 degrees C, since it was easy to oxidize, all oxidized on the front face mostly, 2.5at(s)% Ti remained in the interior, and Zr has controlled the internal amount of Ti well compared with the example 1. Moreover, resistivity was low made with 10 or less microomegacm.

(Example 5) 10at%Hf and 3at%Ta were added to Cu like the example 1. Since Hf tends to have oxidized rather than Zr and Ta was not able to oxidize easily rather than Ti when it oxidizes at 400 degrees C, all oxidized on the front face mostly, 3at(s)% Ta remained in the interior, and Hf has controlled the internal amount of Ta still better compared with the example 4. Moreover, resistivity was low made with 10 or less microomegacm.

(Example 6) 1at%Ti was added to Au like the example 1. It fully oxidized at 400 degrees C, Ti was all mostly oxidized on the front face, an early addition and 1at% Ti which hardly changes remained in the interior, and the internal amount of Ti has been controlled still better compared with the example 5. Moreover, resistivity was low made with 3 or less microomegacm.

(Example 7) At this example, it is SiO₂ to a front face as a glass substrate 12. It is aluminum like an example 1 using what was covered O₂ It oxidized at 250-350 degrees C by gas. Since aluminum was used, -izing of the oxidation temperature was fully able to be carried out [low temperature]. The front face oxidized and the interior was aluminum. Since aluminum was used, resistivity was made low enough with 3 or less microomegacm.

[0062]

[Effect of the Invention] As explained above, the liquid crystal display of this invention is low resistance, and it also had the high chemical resistance in a back process, and, moreover, the covering nature to the glass substrate which needs low temperature treatment is equipped with the good wiring layer. Therefore, when it uses for the wiring for signals of various electronic parts, it contributes to good functional exertion greatly. namely, the case where it uses as formation of the signal wiring of a liquid crystal display, or the electrode of the semiconductor device for a drive to mount -- low -- an address line [****] etc. is realizable Furthermore, this wiring layer is obtained only with heat treatment, without increasing patterning in a liquid crystal display manufacturing process, and etching, and even if it moreover passes through a subsequent heat treatment process and a subsequent etching process, it demonstrates the property which was excellent as a low resistance wiring layer.

[Translation done.]

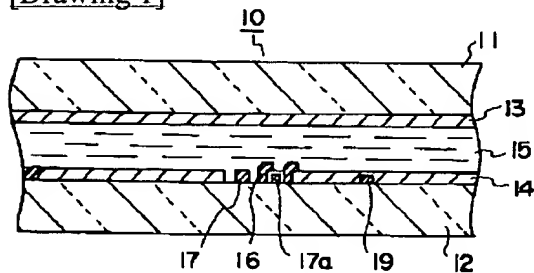
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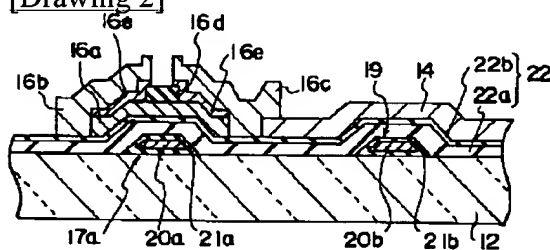
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DRAWINGS

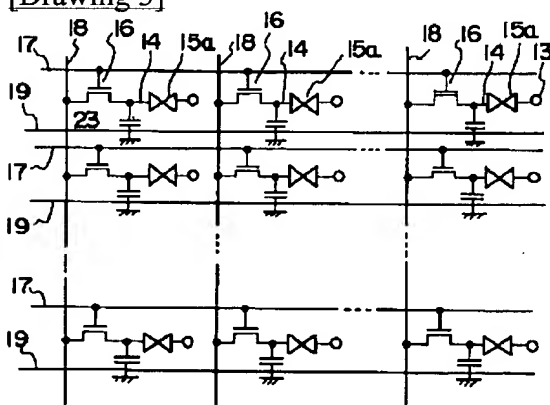
[Drawing 1]



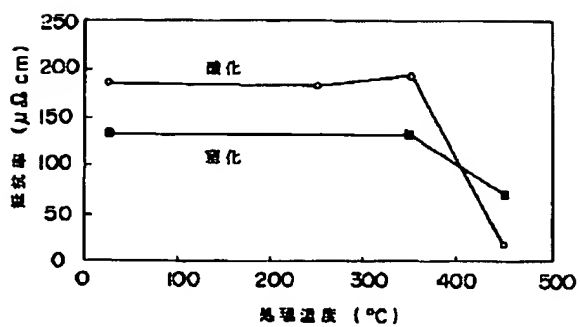
[Drawing 2]



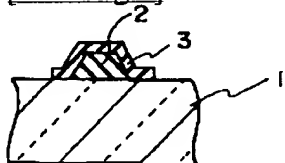
[Drawing 3]



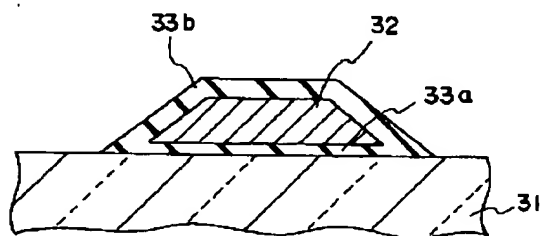
[Drawing 4]



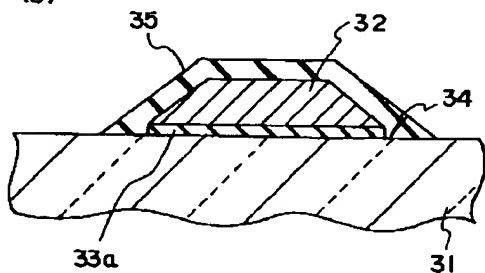
[Drawing 7]



[Drawing 5]
(A)



(B)



[Drawing 6]

